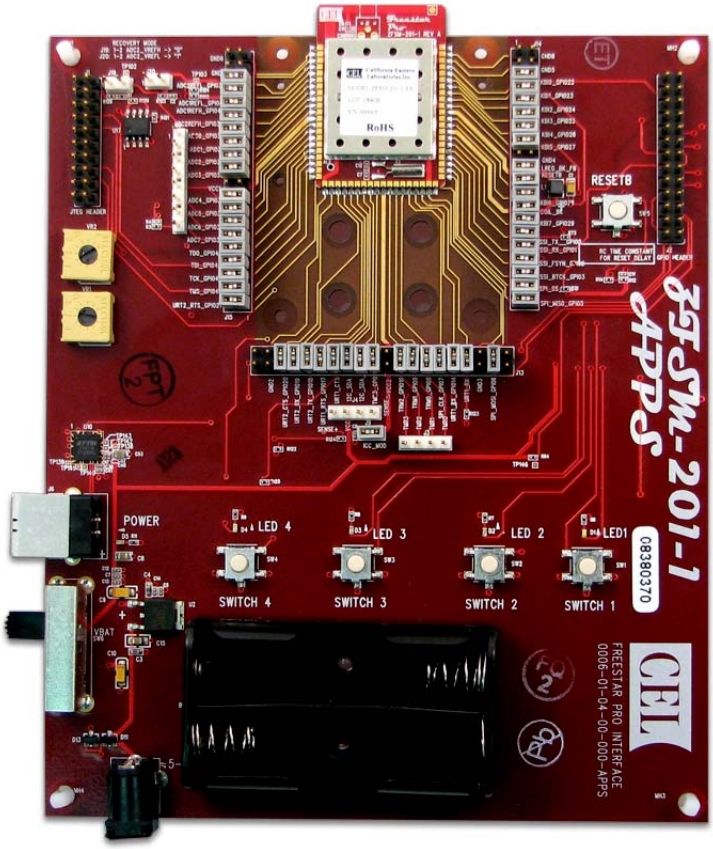
CEL California Eastern Laboratories

Free Star Pro Series

ZFSM-201-EVB-1
Evaluation Board
SMAC Programmers Guide



ZFSM-201-1 FreeStar Pro Module

Document # 0006-00-08-02-000

(Rev B)

Table of Contents

1 Overview

1.1 DESCRIPTION

The **ZFSM201-EVB-1** FreeStar Pro Evaluation Board serves as an interface, evaluation and development tool enabling the user to demonstrate, and evaluate the capabilities of the CEL **ZFSM-201-1,** FreeStar Pro Module.

At the heart of the CEL **ZFSM-201-1** is the Freescale **MC13224V** Platform-in-Package (PiP) transceiver, a 32-bit ARM-based ZigBee radio module and a third-generation 2.4GHz IEEE® 802.15.4 platform.

The 32-bit ARM7 processor and extensive on-chip memory allows designers to eliminate the peripheral host processors often required by 8- and/or 16-bit transceiver solutions. The high level of integration also helps to reduce component count, lowering power consumption and reducing overall system cost.

The evaluation kit provides the end user the ability to quickly become familiar with both the **ZFSM-201-1** FreeStar Pro module's hardware and software. The evaluation boards come preloaded with firmware demonstrating a wireless link and communicating with the supplied ***FreeStar Pro Test Tool*** Graphical User Interface (GUI).

The full application source code of the pre-programmed firmware is based on Freescale's SMAC codebase for ARM7® and is supplied in an IAR Embedded Workbench for ARM project. The source code exercises key features of the MC13224V and provides a good reference or starting point for creating custom applications on the SMAC codebase. The application source code includes the following features:

- RF Evaluation
- Range Test Application
- Packet Error Rate Test (PERT) Application
- Transmitting and receiving on the UART
- Using low power modes
- Reading and writing to Non-Volatile Memory (NVM)
- Reading Analog to Digital Converters
- Using GPIOs

1.2 REFERENCED DOCUMENTS

Table 1 contains the documents that have been referenced by this document (or recommended as additional information). Please consult the appropriate website to check for the latest revisions and editions.

Table 1 – Related and Referenced Documents

Document Title	Document Name / Number
Freescale Semiconductor Documents (www.freescale.com)	
***BeeKit*™** Wireless Connectivity Toolkit Quick Start Guide	BKWCTKQSG
***BeeKit*™** Wireless Connectivity Toolkit User's Guide	BKWCTKUG
***BeeKit*™** Wireless Connectivity Toolkit Software Release Notes	BKWCTKRN
MC13224V Datasheet	MC1322x
MC1322x Reference Manual	MC1322xRM
MC1322x Software Driver Reference Manual	22XDRVRRM
MC1322x Simple Media Access Controller (SMAC) Reference Manual	22xSMACRM
802.15.4 Media Access Controller (MAC) MyWirelessApp	802154MWAUG
802.15.4 Media Access Controller (MAC MyStarNetworkApp	802154MSNAUG
802.15.4 MAC PHY Software Reference Manual	802154MPSRM
Simple Media Access Controller (SMAC) User's Guide	SMACRM

Document Title	Document Name / Number
Freescale ***Test Tool*** User's Guide	TTUG
Note: The Freescale documents listed above will be loaded to the user's PC when installing the ***BeeKit***™ Toolkit found on the CEL Freestar Pro CD.	
CEL Documents (www.cel.com)	
ZFSM-201-1 Datasheet	0006-00-07-00-000
ZFSM-201-KIT-1 Development Kit User Guide	0006-00-08-00-000
ZFSM-201-EVB-1 Evaluation Board Host Serial & RF Protocol Guide	0006-00-08-01-000
ZFSM-201-EVB-1 Evaluation Board SMAC Programmers Guide	0006-00-08-02-000
ZFSM-201-EVB-1 Evaluation Board BeeKit™ Porting Guide	0006-00-08-03-000
ZFSM-201-EVB-1 Evaluation Board MAC Programmers Guide	0006-00-08-05-000
ZFSM-201-KIT-1 Wireless UART Application User Guide	0006-00-08-06-000
ZFSM-201-KIT-1, **ZFSM-201-EVB-1** Erratum	0006-00-08-04-000
Note: The CEL documents listed above are included on the CEL CD.	

2 Code Development in IAR Workbench®

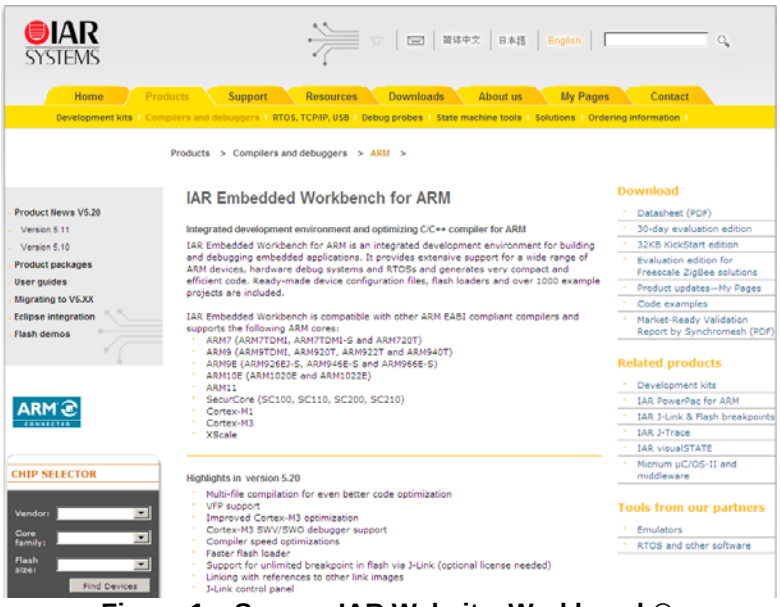


Figure 1 – Screen, IAR Website, Workbench®

2.1 TOOLS

2.1.1 IAR Embedded Workbench® for ARM

Several options exist to purchase or evaluate this program.

- See www.iar.com for details
- The included SMAC project on the CD was developed in IAR Embedded Workbench® for ARM version 5.20.

2.1.2 J-Link

Figure 2 – Photo, J-Link Debugging Probe

The IAR J-Link is necessary for in-circuit debugging.

- See www.iar.com for more details and where to purchase.
- Download and install the latest driver from http://www.segger.com/download_jlink.html

2.2 PROJECT OVERVIEW

2.2.1 File Location on the CD

A complete IAR project, developed based on the ***BeeKit™*** SMAC codebase is included on the CEL CD in the directory \ZFSM-201\Application Source Files\CEL_SMAC_111_v1.2 \CEL_SMAC_111\. It is titled **'CEL_SMAC_111.eww'.**

- The project was based on the **'Generic Application'** template in ***BeeKit™*** (see Figure 3) with changes to a few of the Application Source files.

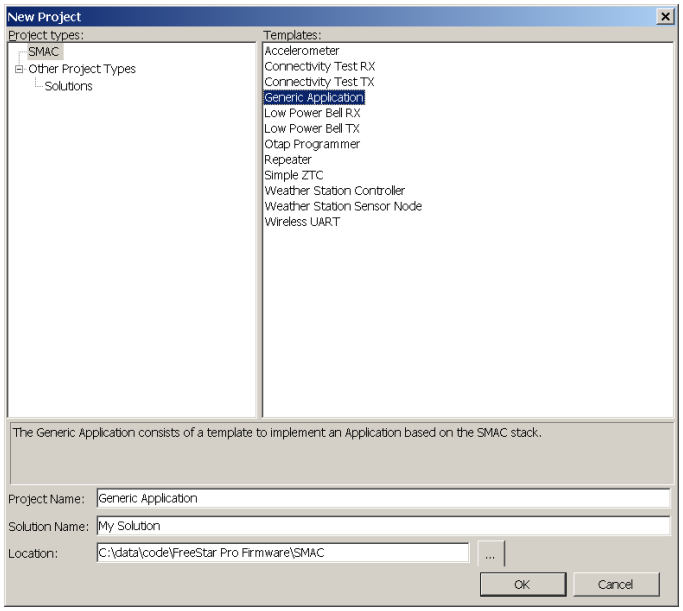


Figure 3 – Screen, BeeKit – New Project

2.2.2 Changes to BeeKit Generated Files

The default project creates one application source file named **`generic_app.c`** contained in the subdirectory \ZFSM-201\Application Source Files\ CEL_SMAC_111_v1.2 \CEL_SMAC_111 \Application\Source. See Table 2.

Table 2 – Code, "`generic_app.c`" – "main" function

`generic_app.c`

```
/*****************************************************************************
* main function
*
* Executes the main function.
*
*****************************************************************************/
void Main(void)
{
  MSG_INIT(TX_msg, &dataTX, NULL);
  MSG_INIT(RX_msg, &dataRX, (callback_t)(application_rx_cb));
  RX_msg.u8BufSize = APP_PACK_SZ;

  generic_app_init();



  for(;;)
  {
//    (void)process_radio_msg();
//    data_indication_execute();
//    process_uart_data();
//    generic_app();
      MainState();
  }
}

/*****************************************************************************
```

In the Main() function in

Table 2, notice that the default contents of the **'for'** loop are commented out and a function named **'MainState()**'; is called instead. This makes porting the application code to new codebases, or other projects quicker and cleaner.

- Several files created by ***BeeKit*™** had to be modified. They include changes to:
    - project settings
    - **`TransceiverConfigMngmnt.h`** file
    - **`generic_app.c`** file
    - **`UartUtil.c`** file
    - **`WirelessLinkMngmt.c`** file

These changes are fully documented at the top of the **'`main_state.c`'** file and are shown in Table 3.

Table 3 – Code, "`main_state.c`" – Changes to BeeStack Generated Code

`main_state.c`

```
////////////////////////////////////////////////////////////////////////////
//  Filename:    main_state.c
//
//  Description:    this is the main state machine for the application
//                  it is kept in a different function than main() so that
//                  it is easier to keep the project in tact as new versions
//                  of the SMAC codebase are released.  An attempt will be made
//                  in this file to document any changes to BeeKit generated
//                  code.  This will again make it easier to keep the project in
```

main_state.c

```
//                  tact as SMAC codebase updates come out.
//
//                  Include main_state.h in the BeeKit generated source file.
//
//                  This function needs to be called in the main() function of
//                  the BeeKit generated application source file.
//
//                  coding follows LSR Software Quality Standard - C Coding Standard
//
//  Micro:          Freescale MC1322x
//  Compiler:       IAR EWARM
//
//  Written by:     Christopher Hofmeister
//
//  Copyright (c)   2008 LS Research, LLC
//                  www.lsr.com
//
//  Version         rev 1.0
//
/////////////////////////////////////////////////////////////////////////////
//      ****** Changes to BeeStack Generated Code ******
//project settings
// 1)  in workspace window under Application->Utilities folder remove
//     display.c and sound.c
//
//
//TransceiverConfigMngmnt.h (In workspace window in IAR under SMAC->Source)
// - find and replace:
//  typedef enum Test_Mode_tag
//  {
//  SMAC_TEST_MODE_IDLE = 0,
//  SMAC_TEST_MODE_CONTINUOUS_RX,//1
//  SMAC_TEST_MODE_CONTINUOUS_TX_NOMOD,//2
//  SMAC_TEST_MODE_CONTINUOUS_TX_MOD,//3
//  SMAC_TEST_MODE_PULSE_PRBS9_TX,//4
//  SMAC_TEST_MODE_PER_RX,//5
//  SMAC_TEST_MODE_RANGE_RX,//6
//  SMAC_TEST_MODE_PER_TX,//7
//  SMAC_TEST_MODE_RANGE_TX,//8
//  SMAC_MAX_TEST_MODES//9
//  } Test_Mode_t;
//
//
//generic_app.c
//  1) find and comment out: print_freescale_logo(); (fucntion call only in static
//     void generic_app_init(void)
//
//  2) the following keep the Switch ISR callback out the the generic_app code that
//     is replaced with a new codebase
//  -find: CRM_RegisterISR(gCrmKB4WuEvent_c, Switch_1_isr);
//  change:  CRM_RegisterISR(gCrmKB4WuEvent_c, Switch1_isr);
```

main_state.c

```
//
//  -find: CRM_RegisterISR(gCrmKB4WuEvent_c, Switch_2_isr);
//  change:  CRM_RegisterISR(gCrmKB4WuEvent_c, Switch2_isr);
//
//  -find: CRM_RegisterISR(gCrmKB4WuEvent_c, Switch_3_isr);
//  change:  CRM_RegisterISR(gCrmKB4WuEvent_c, Switch3_isr);
//
//  -find: CRM_RegisterISR(gCrmKB4WuEvent_c, Switch_4_isr);
//  change:  CRM_RegisterISR(gCrmKB4WuEvent_c, Switch4_isr);
//
//  3)  find:  #define APP_PACK_SZ (125) in generic_app.c and comment out
//           ensure it is defined in application_globals.h
//
//  4)  in list of include files add:
//      #include "application_globals.h"
//      #include "main_state.h"
//
//  5)  in void main (); find and comment out:
//  for(;;)
//  {
//    (void)process_radio_msg();
//    data_indication_execute();
//    process_uart_data();
//    generic_app();
//  }
//
//UartUtil.c
//  1)  comment out:   IntAssignHandler(gUart1Int_c, (IntHandlerFunc_t)UartIsr1);
//  replace with:  IntAssignHandler(gUart1Int_c, (IntHandlerFunc_t)UartIsr1A);
//
//  2)  comment out:   ITC_EnableInterrupt(gUart1Int_c);
//  copy and move to bottom of UART1 init routine:  ITC_EnableInterrupt(gUart1Int_c);
//
//  3)  add extern void UartIsr1A(void); prototype
//
//WirelessLinkMngmt.c
//  1)  find FuncReturn_t MCPSDataRequest (message_t *msg)
//    add
//          #if MANUAL_PA_POWER == TRUE
//          LED_TurnOnLed(LED1);
//          u16LED1_OnTimer = 10;
//          #endif
//
//  2)  add
//      #include "../../Application/Utilities/Leds.h"
//      #include "../../Application/Source/application_globals.h"
//      extern uint16_t u16LED1_OnTimer;
//
////////////////////////////////////////////////////////////////////////////
```

2.3 APPLICATION FILES

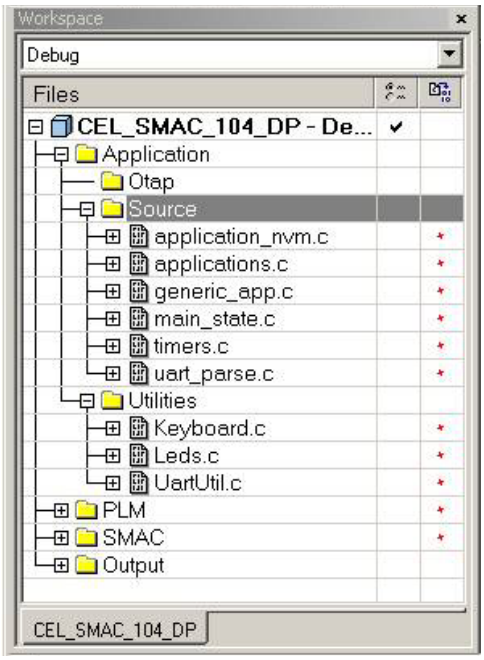


Figure 4 – Screen, IAR Workbench – Application Source and Utility Files

NOTE: The screenshots used in this user guide may be based on a prior release of the corresponding Freescale codebase, for version / project information with regards to the example included on the CEL CD, please refer to Section 2.2. For the latest Freescale codebase, please download the Freescale BeeKit™ from the Freescale website.

2.3.1 Source Files

As shown in Figure 4, six application source files are included in the Sample Project. Except for generic_app.c, each file also has a corresponding header (.h) file.

- **`application_nvm.c`** Contains the source code necessary to write to NVM
- **`applications.c`** Contains the base applications for the CEL/SMAC release
  - range test
  - packet error rate test
  - continuous receive
  - pseudo random binary sequence tx
- **`generic_app.c`** See description in Section 0 above
- **`main_state.c`** See description in Table 3 above
- **`timer.c`** Enables and processes timer related functions
- **`uart_parse.c`** Handles incoming and outgoing UART messages.

2.3.2 Utility files

The following software modules included with the project when made by ***BeeKit™*** are located in the **'Utilities'** folder as shown in Figure 4.

- **`Keyboard.c`** Contains the keyboard initialization function
- **`Leds.c`** Contains utility functions for the LEDs management
- **`UartUtil.c`** Contains the UART utilities

2.4 PLM AND SMAC SOURCE FILES

Additional source files are included in the project when made by ***BeeKit™*** and stored in the PLM and SMAC directories. They are shown in Figure 5 below.

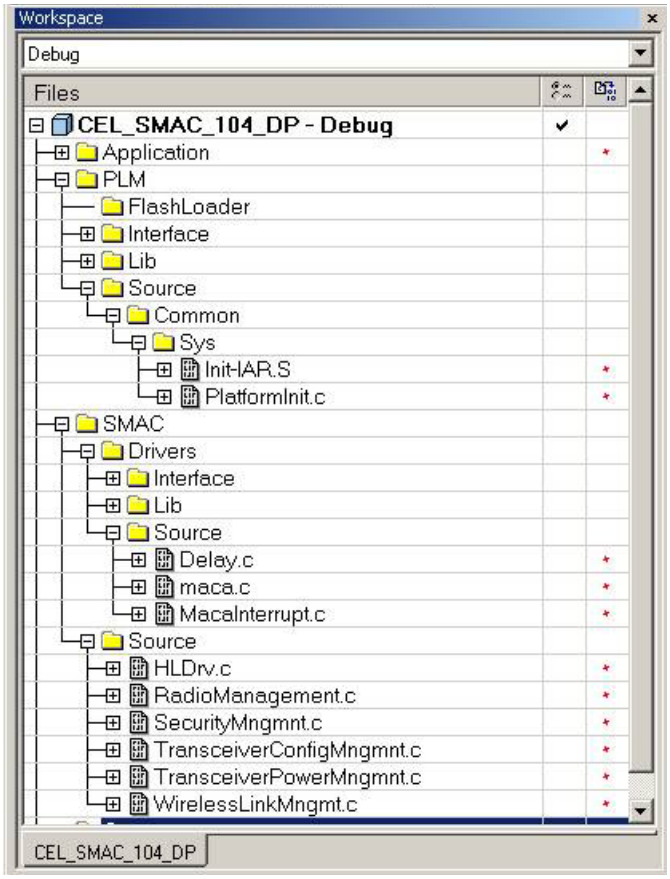


Figure 5 – Screen, IAR Workbench – PLM and SMAC Source Files

2.5 DEBUG/RELEASE WORKSPACE MODE

During development it is strongly recommended that the **'Workspace'** be kept in **'Debug'** mode as shown in Figure 6.

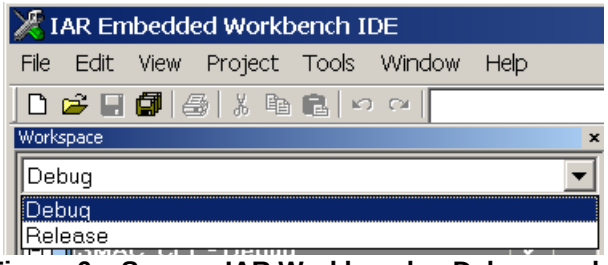


Figure 6 – Screen, IAR Workbench – Debug mode

2.6 GENERATING AN OUTPUT FILE

The IAR IDE does not generate a .bin file automatically. The user must do the following:

- Right click on the project name. In Figure 7 below the project name is **'CEL_SMAC_104_DP'**. Select **'Options…'** from the drop down Menu List.

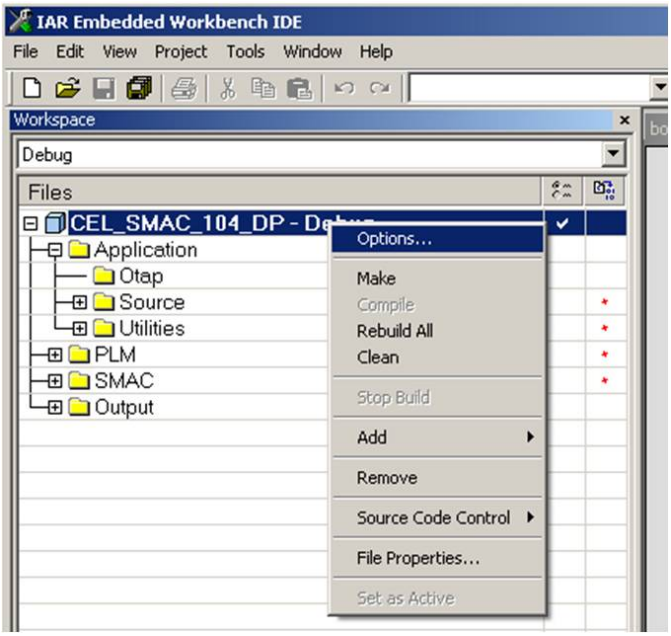


Figure 7 – Screen, IAR Workbench – Project Output Options

- In the category **'Output Converter'**, check the **'Generate additional output'** box and in the **'Output format'** pull down box select **'binary'** as shown in Figure 8. Click **'OK'**.

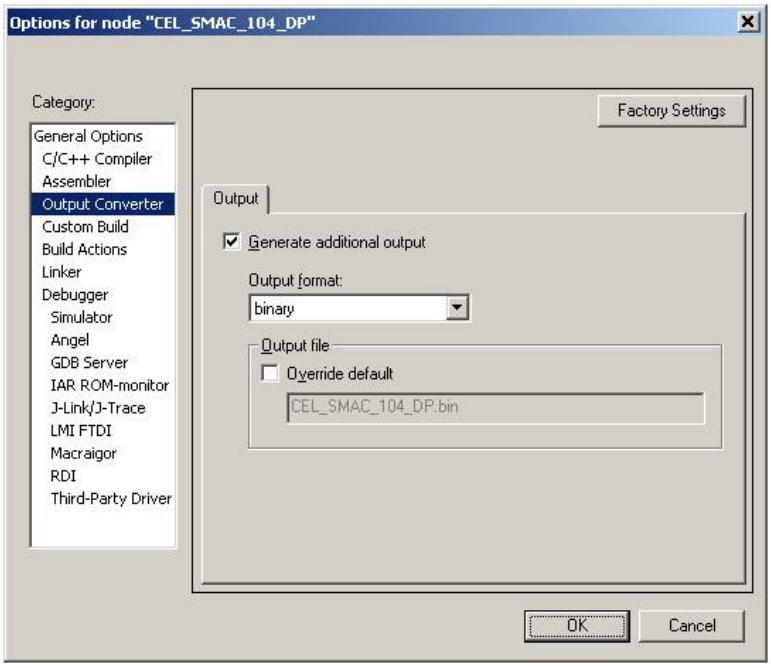


Figure 8 – Screen, IAR Workbench – Generating an Output File

2.7 J-LINK SPEED

2.7.1 Change the J-Link speed by following steps:

- Right click on the project name. In Figure 7 below the project name is '**CEL_SMAC_104_DP'**. Select **'Options…'** from the Menu List.
- In the **'J-Link/J-Trace'** category, set the **'Reset'** to **'Software'** and the **'JTAG/SWD speed'** to **'Adaptive'** as shown in Figure 9.

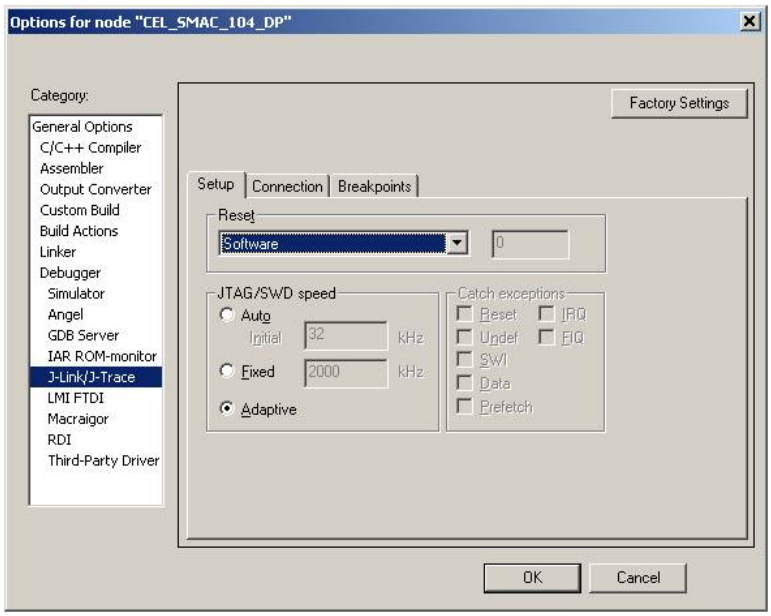


Figure 9 – Screen, IAR Workbench – Setting JTAG/SWD Speed

2.8 OPTIMIZATIONS

Use of optimizations is up to the developer. For development and debugging it is strongly encouraged to keep the optimization level at 'None' as shown in Figure 10.

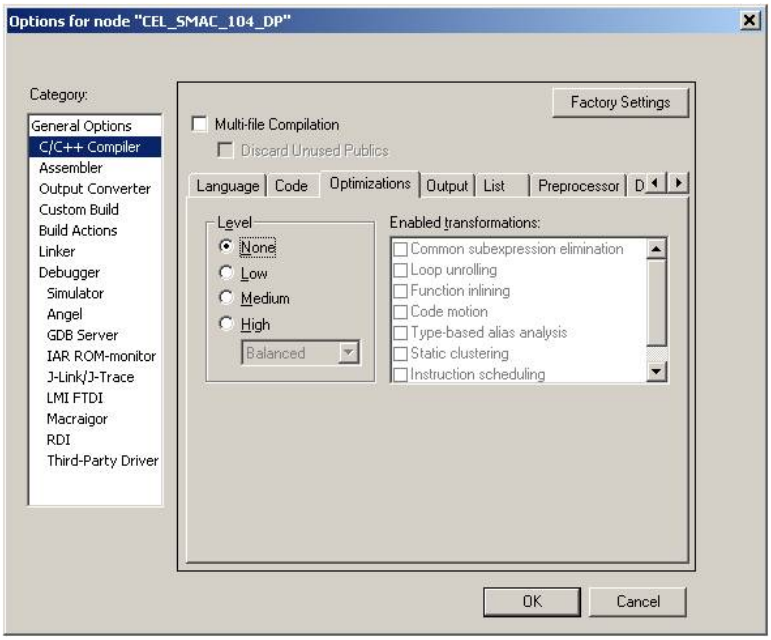


Figure 10 – Screen, IAR Workbench - Optimizations

2.9 MAIN IAR FEATURES

2.9.1 Building a Project

Under the **'Project'** menu several options exist to **'Make'**, **'Compile'**, or **'Rebuild All'** code.

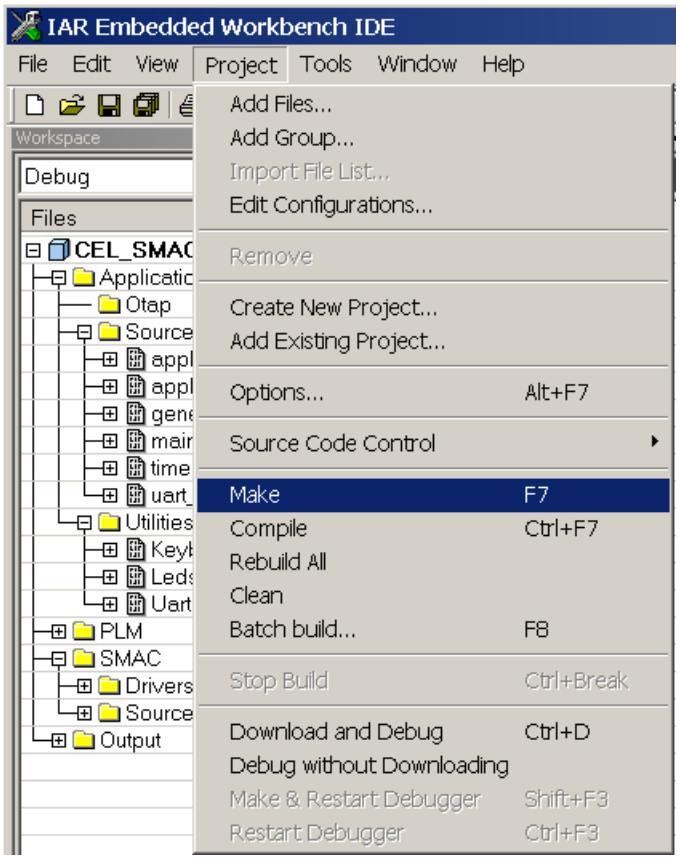


Figure 11 – Screen, IAR Workbench – Project Menu

2.9.2 Downloading into Flash:

- Ensure J-Link is connected to PC though the USB cable.
- Ensure FreeStar Pro Evaluation Board is connected to the J-Link though the ribbon cable plugged into the JTAG Header (J1).
- Ensure the power switch (SW6) is in the ON position as indicated by the red power LED (D5) being on.
- Under the **'Project'** menu select **'Download and Debug'** as shown in Figure 12.

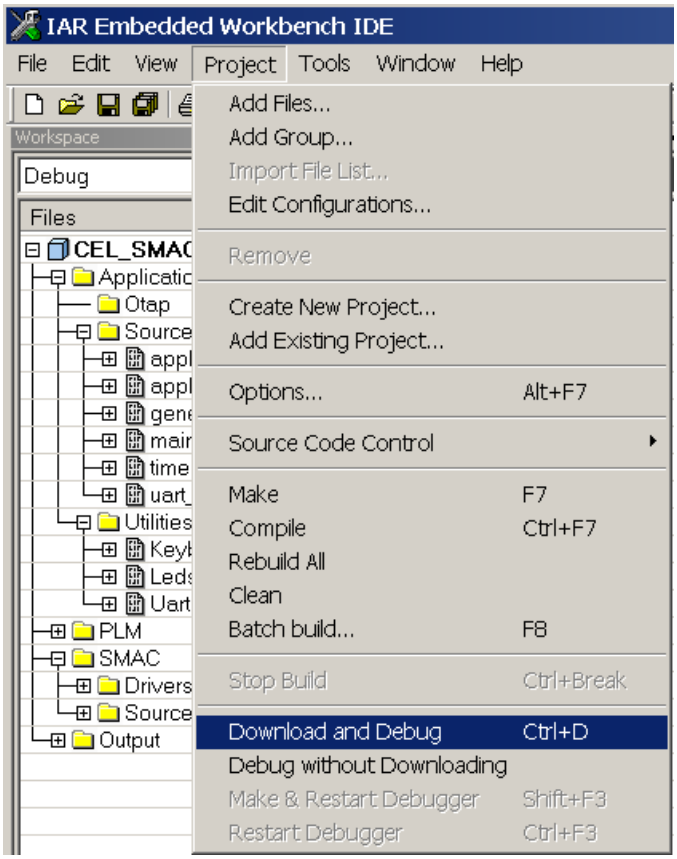


Figure 12 – Screen, IAR Workbench – Download and Debug

3 SMAC Development with Sample Application

3.1 CODE DEVELOPMENT

The MC13224V is a powerful ARM7 based processor integrated with an 802.15.4 radio. Although the Sample Project provided does not exercise every available feature and option, many software components for developing custom applications are included, such as:

- Turning LED's on and off with a timer
- De-bouncing switches
- Sending and receiving RF messages
- Using Analog to Digital Converters
- Using UART to send and receive data
- Using low power modes with different wakeup sources available.
- Using Non-Volatile Memory
- Using internal timers to generate interrupts.

3.2 STATE DIAGRAMS

The following sections describe the states used in the Sample Project with the goal of helping the user to understand the code, and how to modify it for a custom application.

3.2.1 Main State Diagram

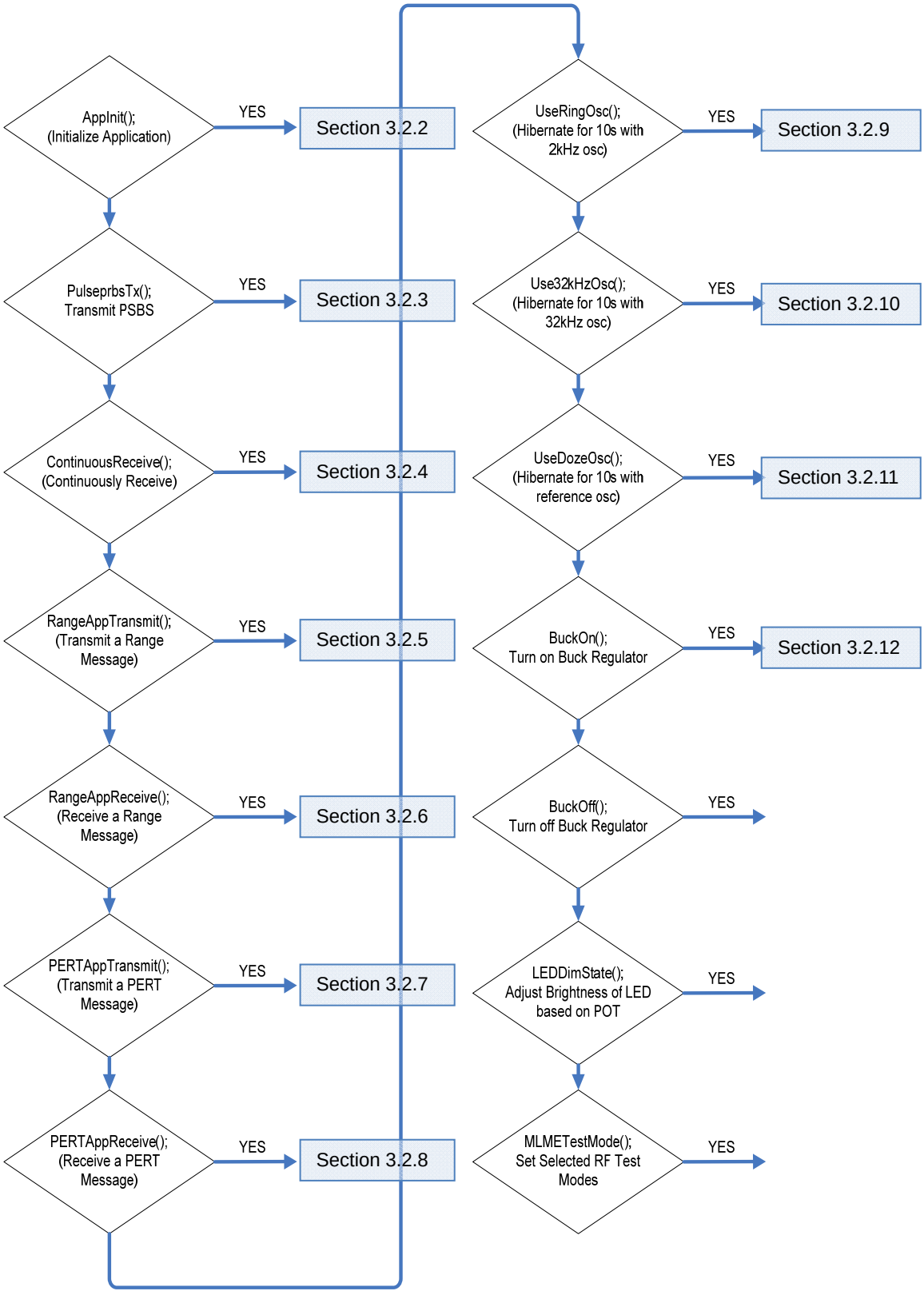


Figure 13 – Diagram, Main State

3.2.2 AppInit State Diagram

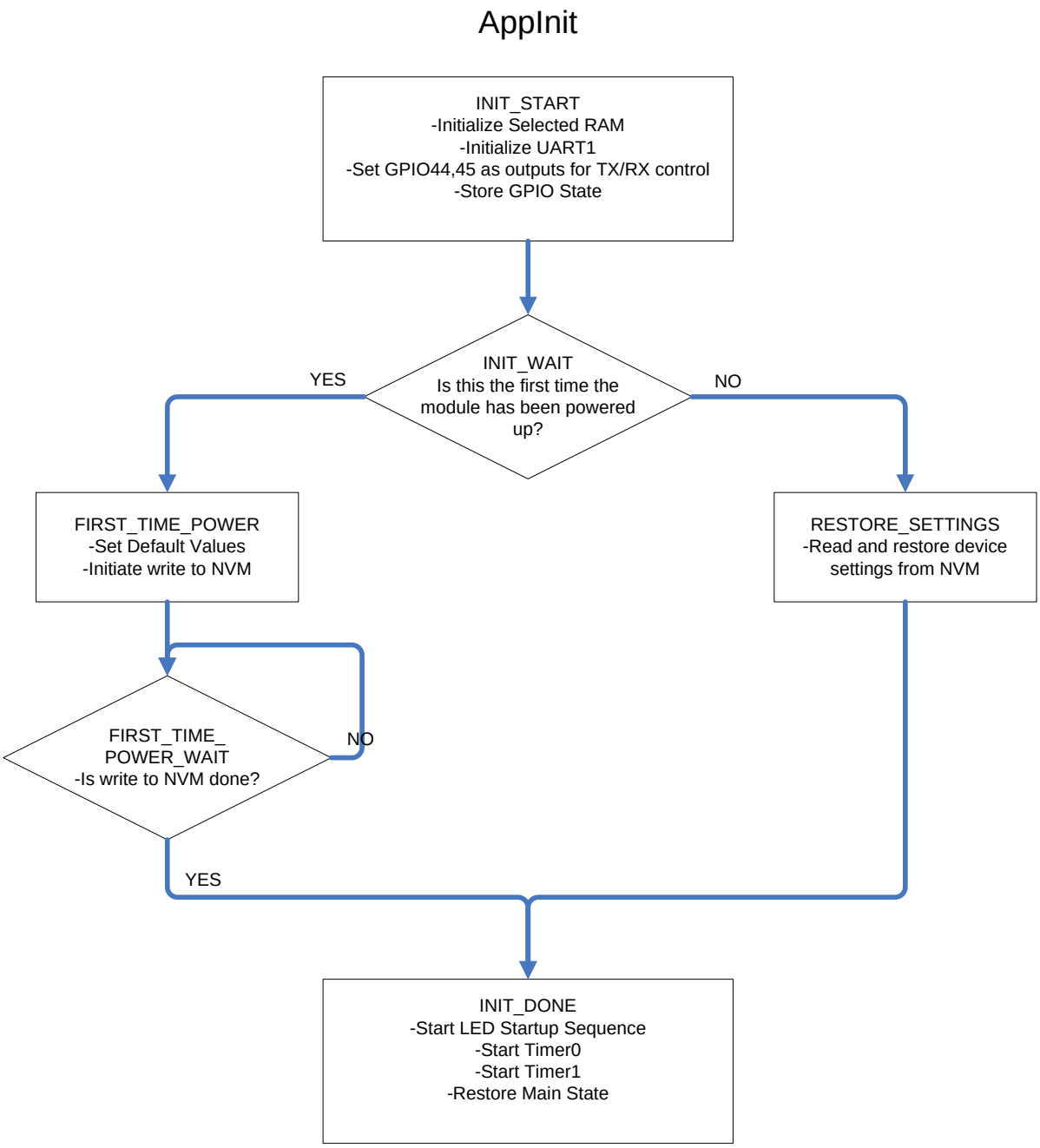


Figure 14 – Diagram, AppInit State

3.2.3 Pseudo Random Binary Sequence (PRBS) State Diagram

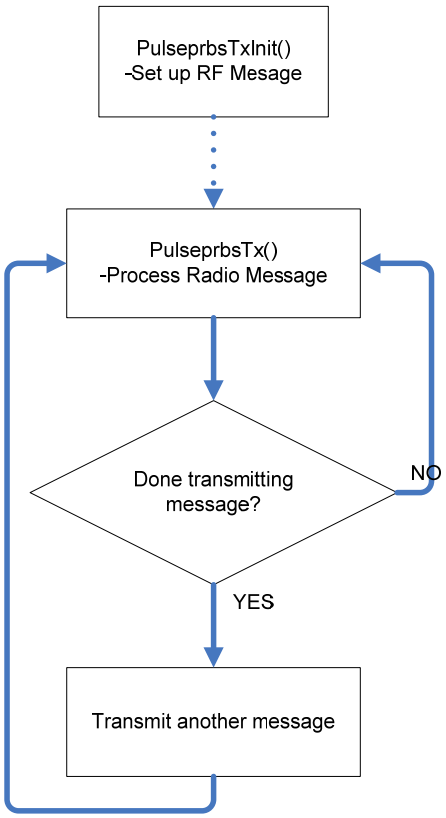


Figure 15 – Diagram, PRBS State

3.2.4 Continuous Receive State Diagram

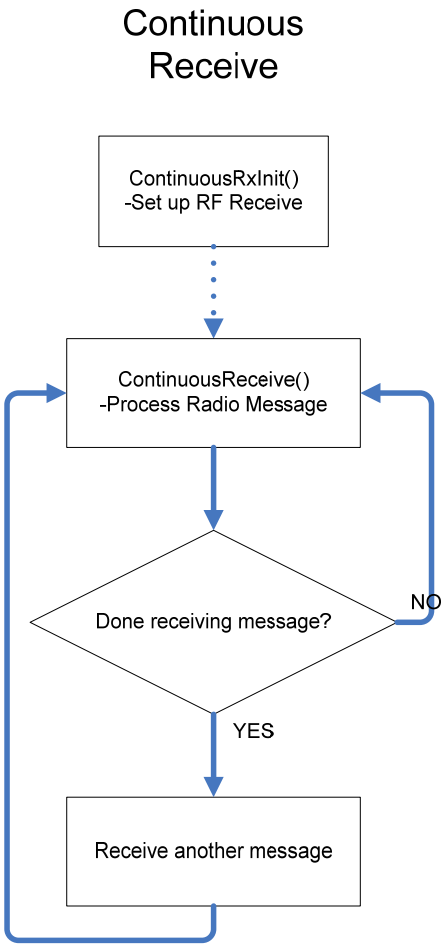


Figure 16 – Diagram, Continuous Receive State

3.2.5 Transmit Range Message State Diagram

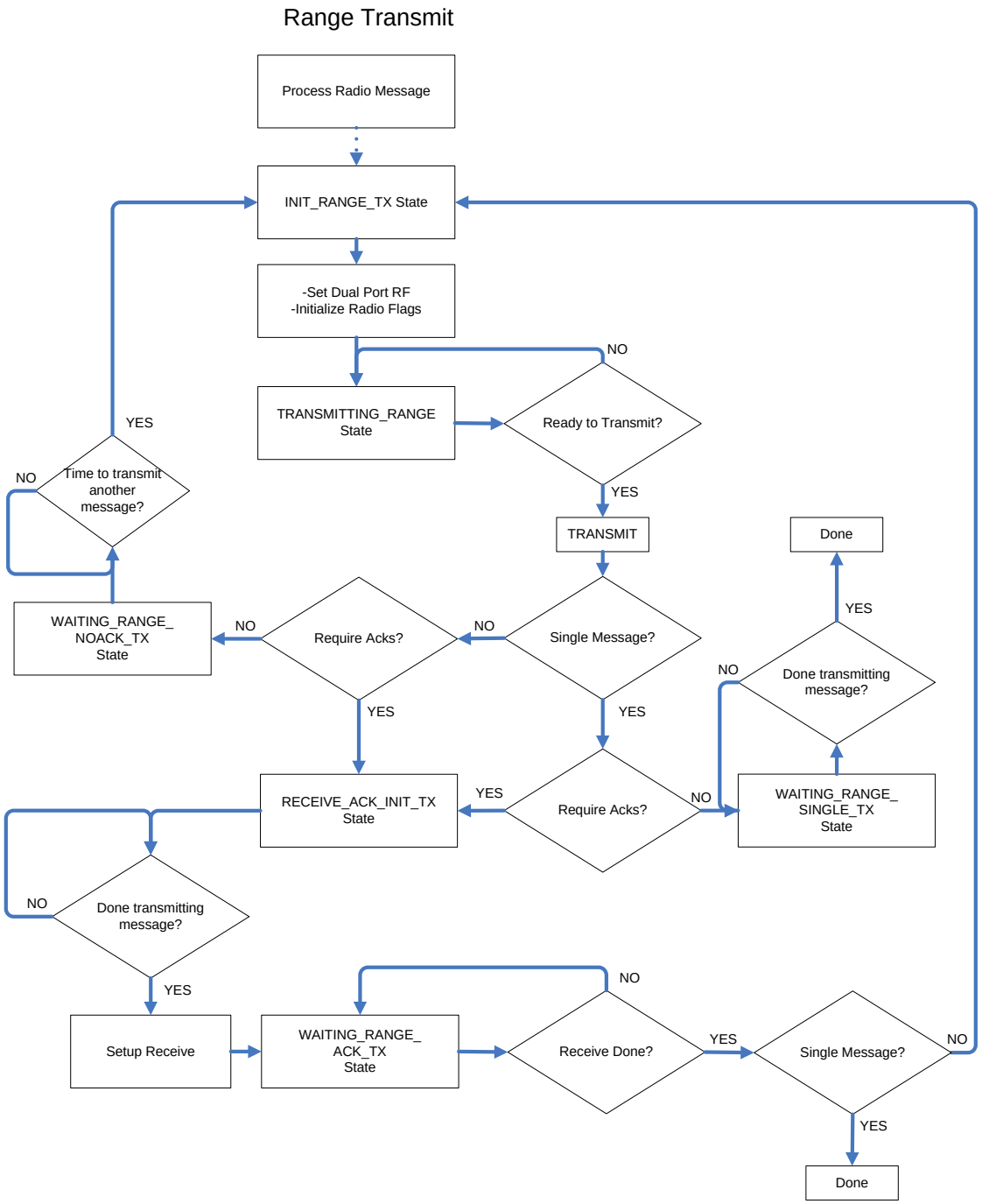


Figure 17 – Diagram, Transmit Range Message State

3.2.6 Receive Range Message State Diagram

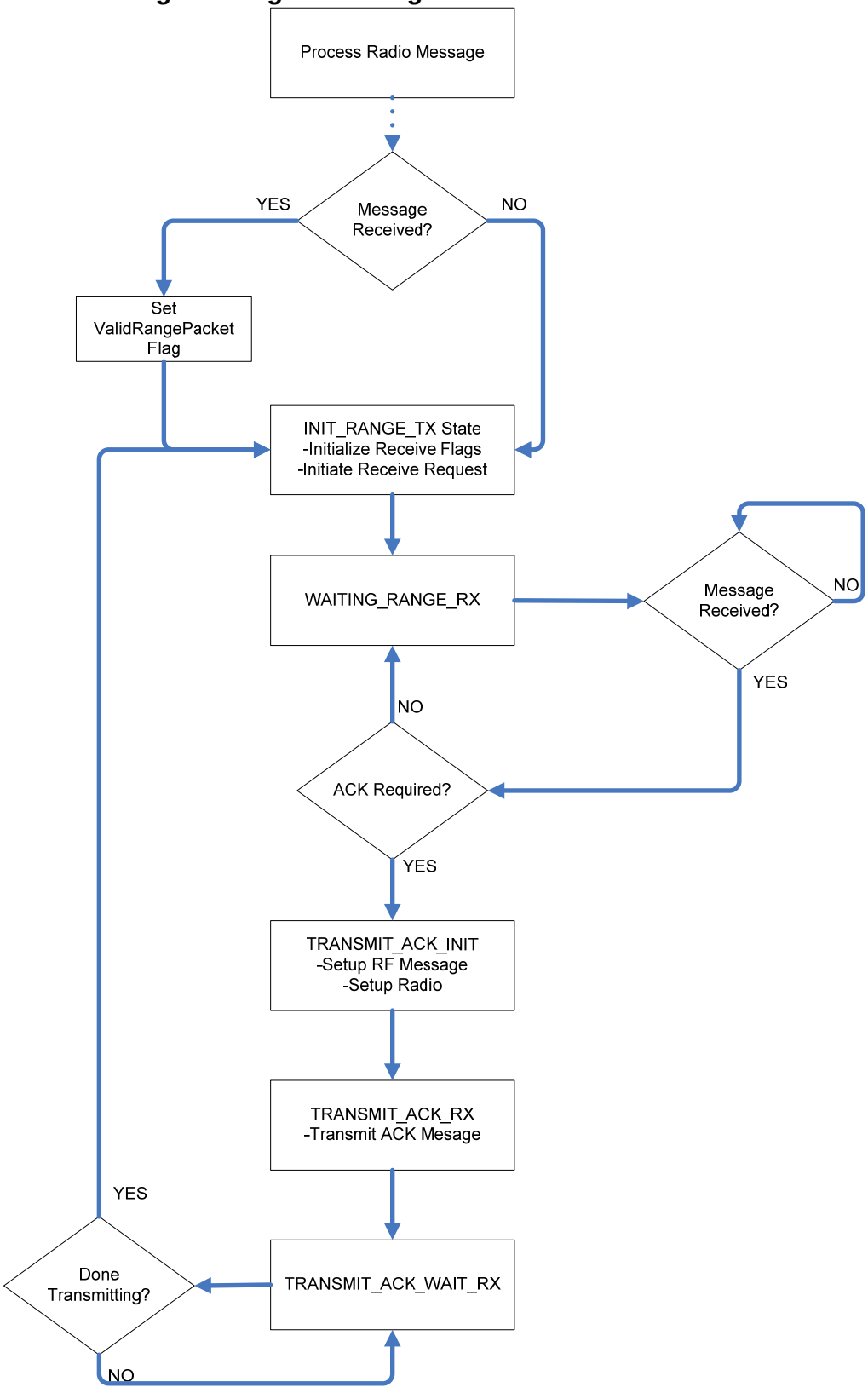


Figure 18 – Diagram, Receive Range Message State

3.2.7 PERT Transmit Message State Diagram

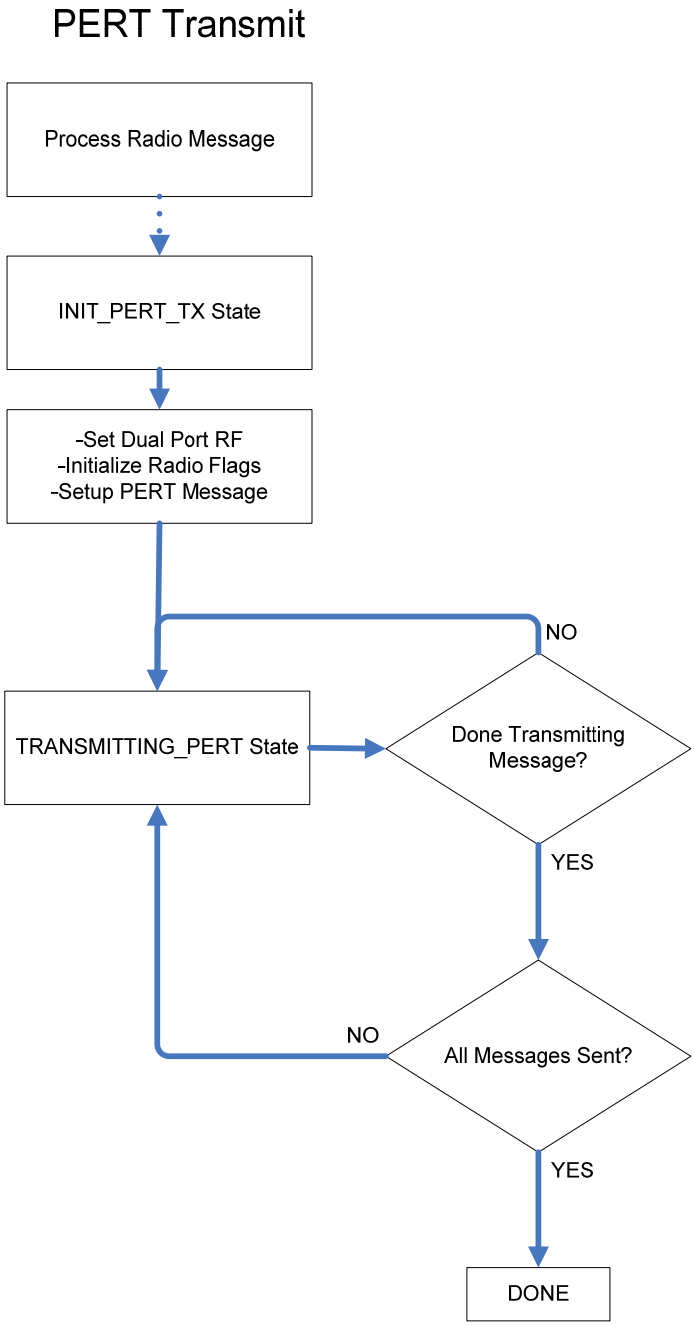


Figure 19 – Diagram, PERT Transmit Message State

3.2.8 PERT Receive Message State Diagram

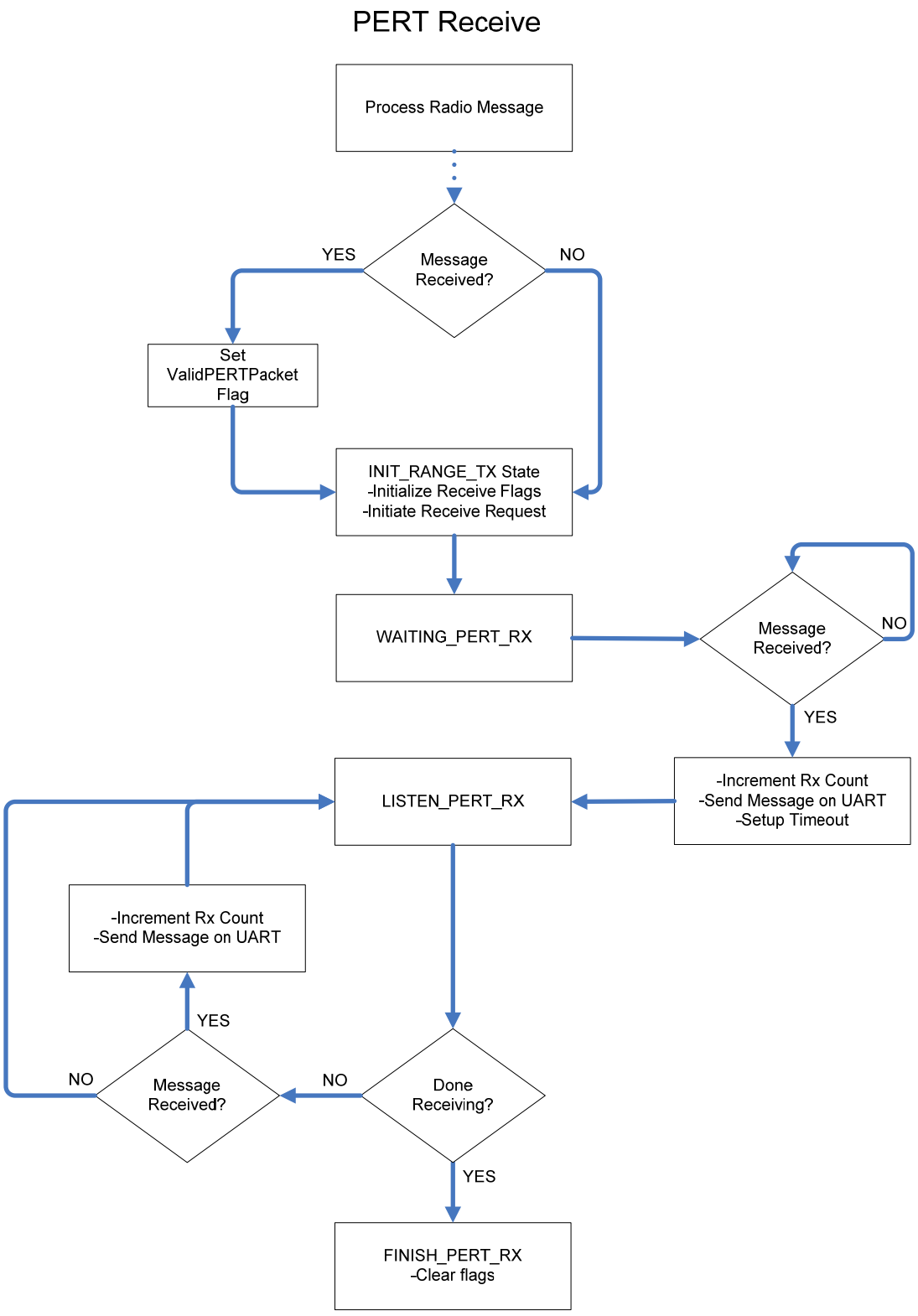


Figure 20 – Diagram, PERT Receive Message State

3.2.9 Hibernate using 2kHz Oscillator State Diagram

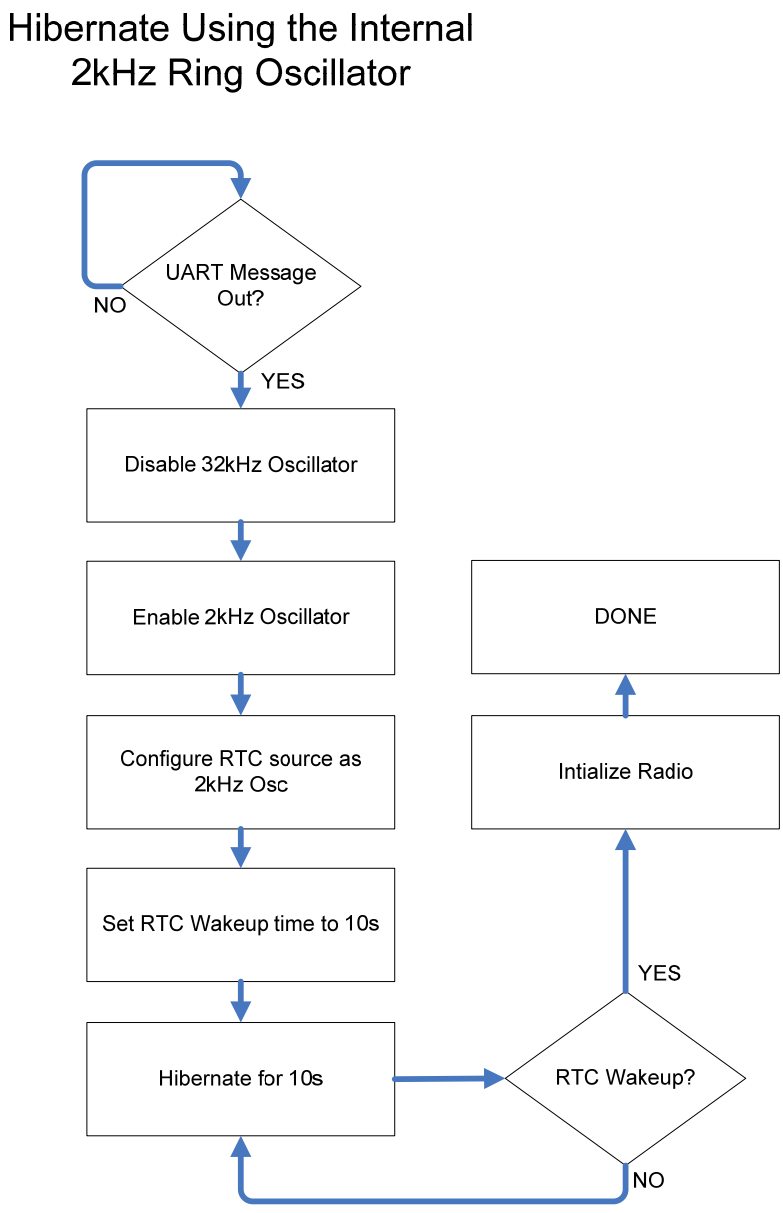


Figure 21 – Diagram, Hibernate using 2kHz Oscillator State

3.2.10 Hibernate using 32kHz Oscillator State Diagram

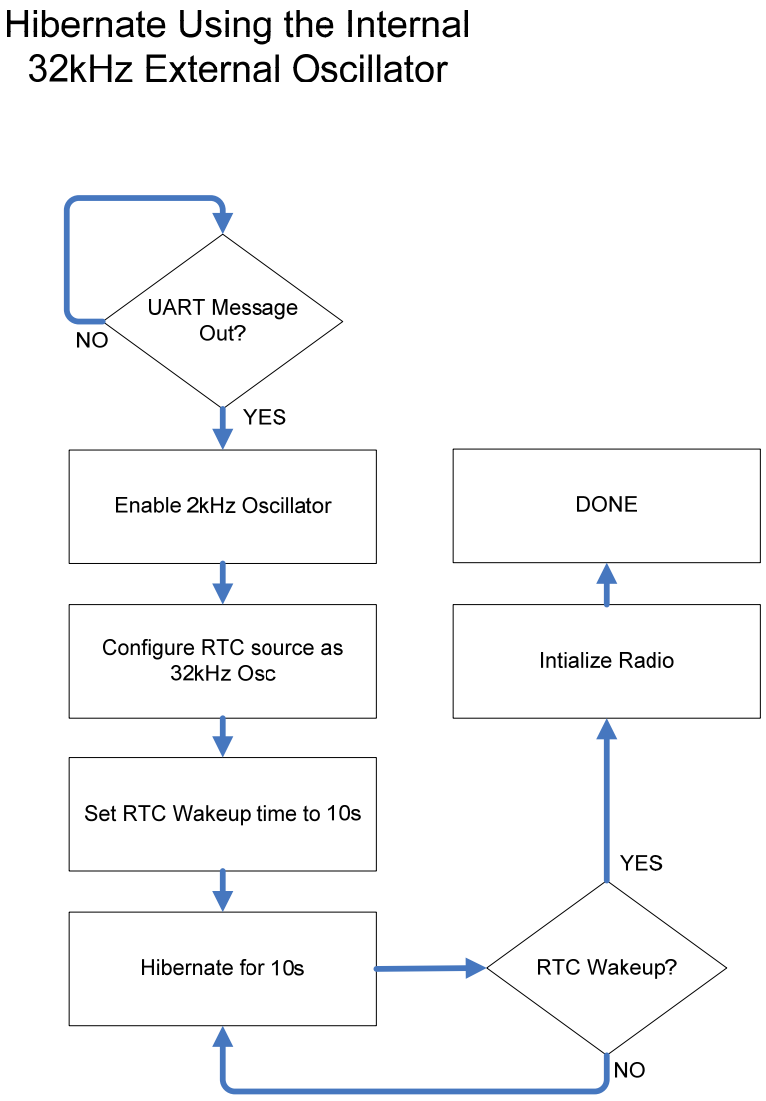


Figure 22 – Diagram, Hibernate using 32kHz Oscillator State

3.2.11 Doze using 24MHz Reference Oscillator State Diagram

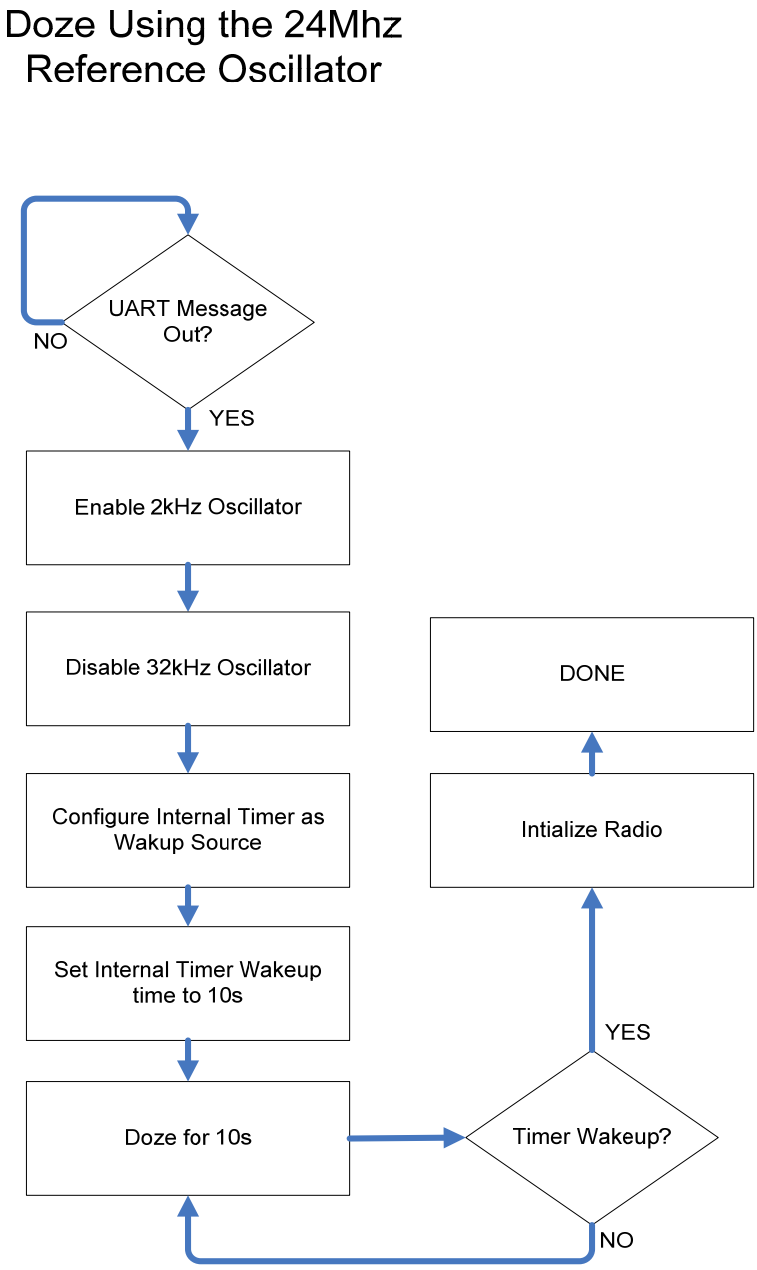


Figure 23 – Diagram, Doze using 24MHz Oscillator State

3.2.12 Enable Buck Regulator State

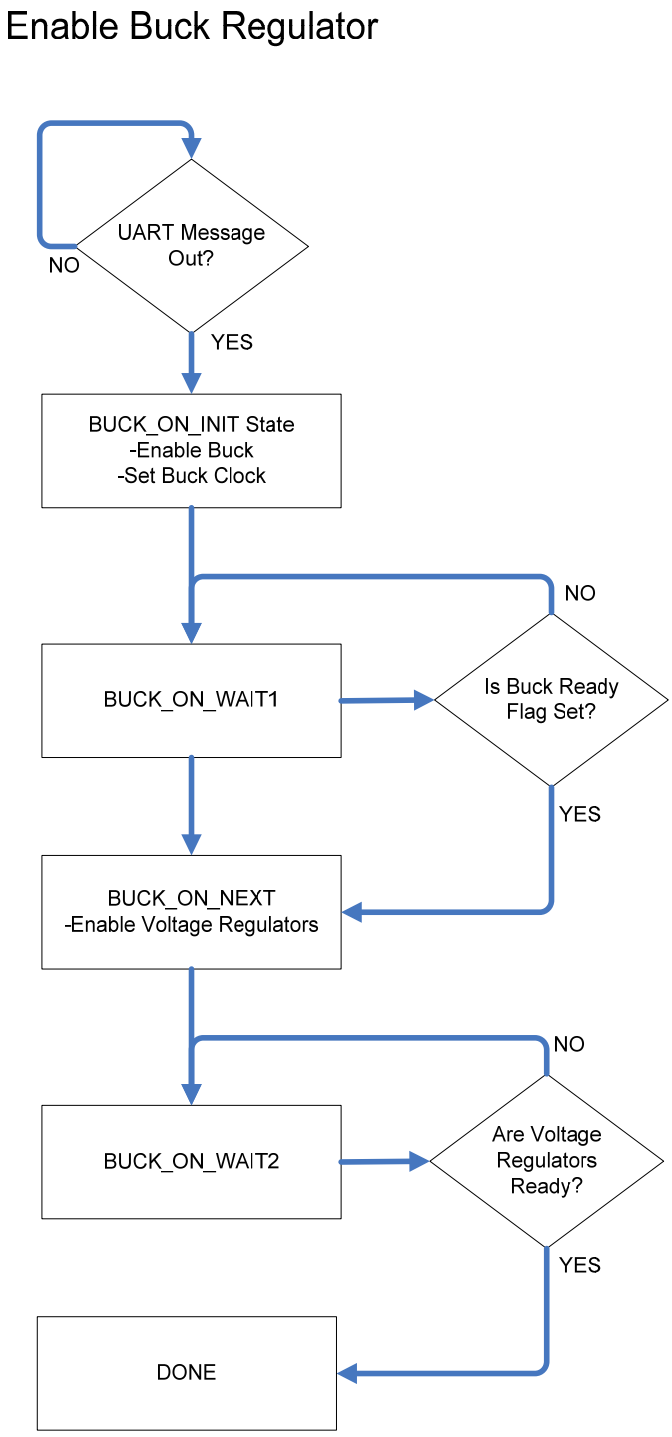


Figure 24 – Diagram, Enable Buck Regulator State

3.2.13 Save to NVM State Diagram

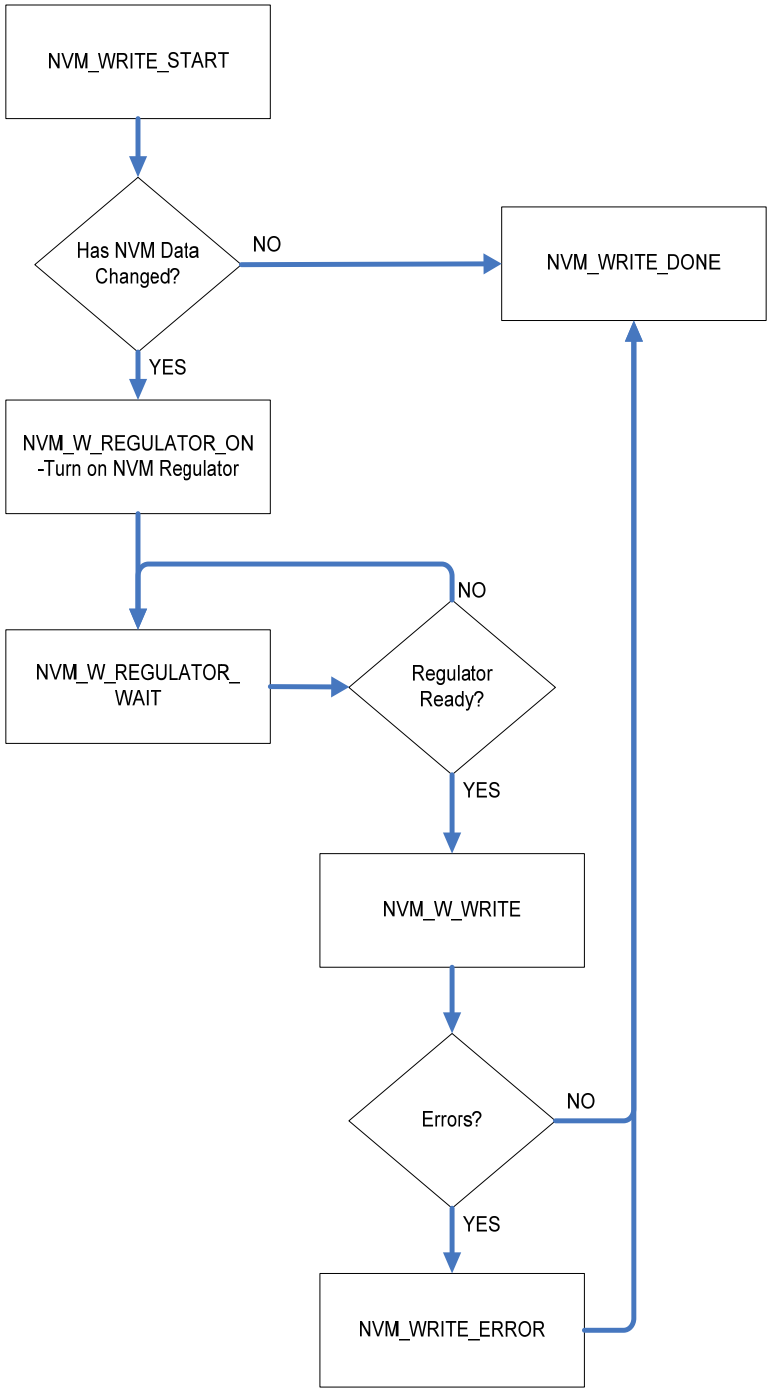


Figure 25 – Diagram, Save to NVM State

3.2.14 NVM Read State Diagram

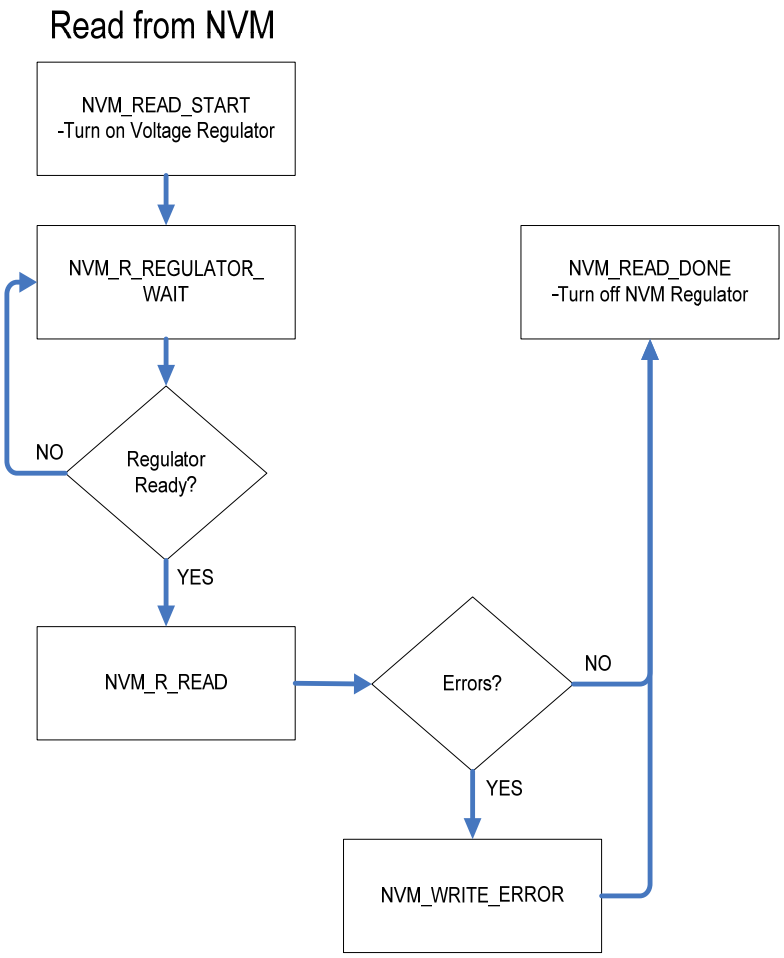


Figure 26 – Diagram, NVM Read State

3.2.15 UART Receive State Diagram

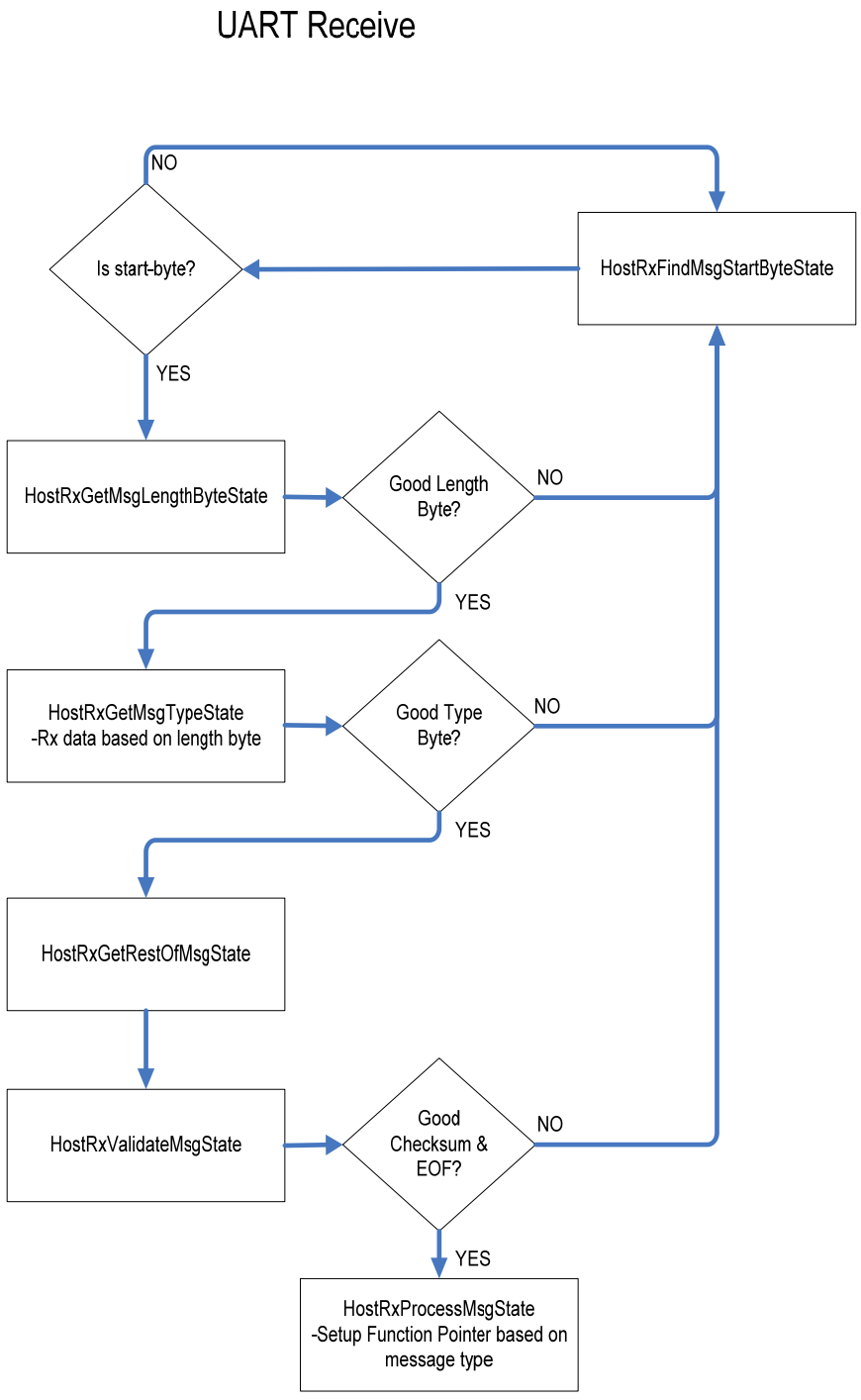


Figure 27 – Diagram, UART Receive State

3.2.16 Reading ADC's State Diagram

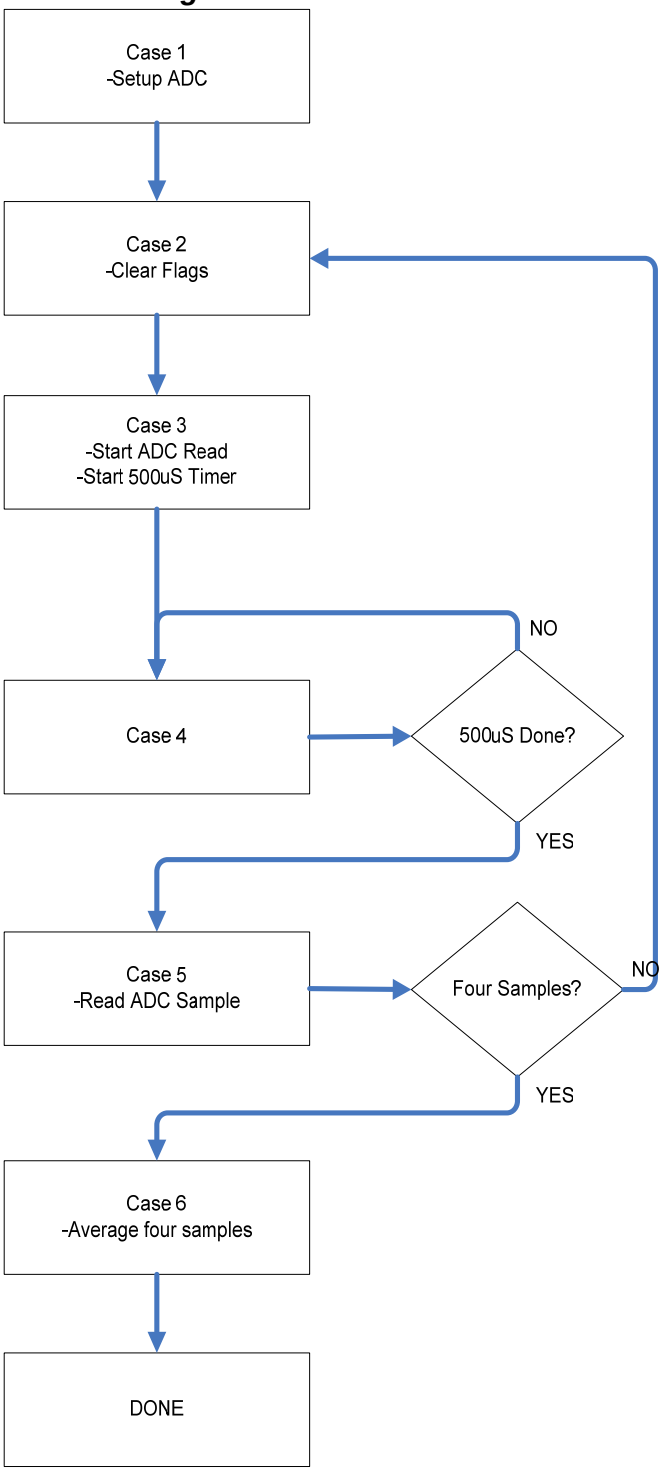


Figure 28 – Diagram, Reading ADC's State

3.3 TRANSMITTING AN RF MESSAGE

3.3.1 More information

See Freescale documents ***"Simple Media Access Controller (SMAC) User's Guide"*** (Freescale Doc # SMACRM) and ***"MC1322x Simple Media Access Controller (SMAC) Reference Manual"*** (Freescale Doc # 22xSMACRM) for more information.

- The Tx_msg structure contains a pointer to the Transmit Buffer named dataTx. These are setup by ***BeeKit™*** and are declared in **`generic_app.c`** if using the SMAC Sample Project contained on the CD.
- Setup the size of the Message by setting the TX.msg.u8BufSize to the size of the message.
- Copy the message to transmit into the dataTx buffer using the Tx_msg structure and pointer. For an example see the SetupRFTxMessage() function in **`applications.c`**. The function is setting up a message that matches the CEL SMAC RF Protocol that is defined in the ***"ZFSM-201-EVB-1 Evaluation Board Host Serial & RF Protocol Guide"*** (CEL Doc #0006-00-08-01-000).
- Initiate a request to transmit using the SMAC API MCPSDataRequest(&TX_msg). See the RangeAppTransmit() function in **`applications.c`** for an example.
- The (void) process_radio_msg() must be routinely called to run the radio state machine. It is the first function called in the RangeAppTransmit() function in **`applications.c`**.
- Before attempting to transmit or receive another RF message ensure the first message was transmitted. Use the (s_tx_msg_final_state(TX_msg) macro to tell when the device is done transmitting the message. This macro only looks at the end result, not what happened. Further coding could be done by the application to track the status of the message and verify complete success. See the RangeAppTransmit() function in **`applications.c`**.

3.4 RECEIVING AN RF MESSAGE

3.4.1 More information

See Freescale documents ***"Simple Media Access Controller (SMAC) User's Guide"*** (Freescale Doc # SMACRM) and ***"MC1322x Simple Media Access Controller (SMAC) Reference Manual"*** (Freescale Doc # 22xSMACRM) for more information.

- The Rx_msg structure contains a pointer to the Receive Buffer named dataRx. These are setup by ***BeeKit™*** and are declared in **`generic_app.c`** if using the SMAC Sample Project contained on the CD.
- A receive buffer size and callback function for when data is received must be setup. These are setup by ***BeeKit™*** and are seen in **`generic_app.c`** in the main() function if using the SMAC Sample Project contained on the CD.
- Initiate a request to transmit using the SMAC API MLMERXEnableRequest(&RX_msg, 0x00000000). See the RangeAppReceive() function in **`applications.c`** for an example.
- Use the is_rx_msg_final_state(RX_msg) macro to tell when the device is done trying to receive a message. This macro only looks at the end result, not what happened. Further coding could be done by the application to track the status of the receive state machine. See RangeAppReceive() function in **`applications.c`** for an example.
- The callback function, in the SMAC Sample Project contained on the CD, calls the void application_rx_cb (void) if RF data is received. This function does not validate the data, nor indicate a VALID message. It simply sets the gbDataIndicationFlag to 'TRUE'. It is up to the application to check this flag and validate the RF message.

- The process_radio_msg() function must be routinely called to run the radio state machine. It is the first function called in the RangeAppReceive() function in **`applications.c`**.

3.5 CHANGING OR QUERYING THE RF CHANNEL

3.5.1 More information

See Freescale documents ***"Simple Media Access Controller (SMAC) User's Guide"*** (Freescale Doc # SMACRM) and ***"MC1322x Simple Media Access Controller (SMAC) Reference Manual"*** (Freescale Doc # 22xSMACRM) for more information.

- The SMAC codebase contains an API to change the channel named MLMESetChannelRequest().
- The SMAC API called MLMEGetChannelRequest() can be used to read the current RF channel.
- When a request to change the channel is received on the UART the ChangeChannel() function is used. It is found in **`main_state.c`**. The function checks the data range of the received UART data and uses both of the SMAC API's to check and change the channel.

3.6 CHANGING THE RF POWER

3.6.1 More information

See Freescale documents ***"Simple Media Access Controller (SMAC) User's Guide"*** (Freescale Doc # SMACRM) and ***"MC1322x Simple Media Access Controller (SMAC) Reference Manual"*** (Freescale Doc # 22xSMACRM) for more information.

- The SMAC codebase contains an API to change the power named MLMEPAOutputAdjust(). It is called in the ChangePower() function in the **`main_state.c`**.
- For example, this ChangePower() function is used in the SetManualRangeTx() function in **`applications.c`**.

3.7 RECEIVING A UART MESSAGE

UART messages are parsed as they are received with the use of function pointers.

- Each state of the function checks for valid data (start byte, message type, checksum and end-of-frame).
- If a valid UART message is received another function pointer is set up based on the message Type.
- This function will respond as appropriate for the message type and received data.
- See **`uart_parse.c`**

3.8 TRANSMITTING A UART MESSAGE

The MC13224V has an internal 32-byte transmit buffer.

- Data is fed into the buffer and as interrupts occur, the application code waits for the buffer to empty.
- See **`uart_parse.c`** and the UartIsr1A function in **`main_state.c`**

3.9 TIMERS

A variety of options exist on the MC13224V for periodic timers that expire and generate an interrupt.

- The sample SMAC project on the CD uses Timer0 to generate an interrupt every 5mS.
- See **`timers.c`** for setup and usage.
- A variety of the other timers based on Timer0 can be set up and updated every time Timer0 expires. See the UpdateTimer0() function in **`main_state.c.`**

3.10 EVENTS

- Low priority events (turn LED's off, responding to switches) are handled in the EventDo() function in **`main_state.c`**.
- Other events can be easily added.

3.11 READING ADC'S

- Two A/D converters are connected to Potentiometers on the CEL **ZFSM-201-EVB-1** FreeStar Pro Evaluation Board.
- Another A/D internal to the **MC13224V** can be used to monitor the battery voltage.
- It is important to monitor the battery voltage when the Buck Regulator is active. If the battery voltage falls below 2.5V the Buck needs to be placed in bypass mode. See Freescale Semiconductors' ***"MC1322x Reference Manual"*** (Freescale Doc # MC1322xRM)**.**
- When a GUI message is received to query the A/D channels a Timer is set up to read the A/D's every 500mS.
- The ADC_Setup() function in **`main_state.c`** sets up the A/D's.
- Although the battery is used as the A/D reference, its value is based on an internal 1.2V reference.
- Value read back by the 9th A/D input (battery) is actually a 1.20V reference.
- To obtain the actual power supply use the following formula:
    - Power Supply Voltage = (4095*1.20)/Power Supply A/D result
- This 'adjusted' Power Supply Value can be used to improve the accuracy of the A/D values obtained from the power supply.
    - ADC Voltage = (A/D result /4095) * Power Supply Voltage

3.12 USER INPUTS (SWITCHES)

- When an interrupt is detected on a switch, a 25mS Timer based off Timer0 is started. Upon expiration the switch input to the **MC13224V** is read. If it is low (pressed) a valid switch press flag is set. The EventDo() function in **`main_state.c`** will respond to the switch event.

4 REVISION HISTORY

Revision	Date	Description
Preliminary	28Oct08	Preliminary Release
A	04Feb09	Updated Table #1
B	22May09	Updated for BeeKit v1.9.5 / SMAC v1.11 Release